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Ratios and Isopleth Maps in Regional Investigation of Agricultural Land Occupance

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Geographers, as well as workers in several of the other disciplines, have long employed certain ratios in the investigation of regions. A few of these ratios, notably that of population to area, have been used as the basis of isopleth maps,[1] which type of map reveals more effectively than any other instrument so far devised the areal spread and variation of these ratios. Most of the ratios employed by geographers, however, have been set forth in statistical tables rather than in maps. Such ratios for the most

[1] The interest of the writer in ratios and isopleth maps was first aroused by a study of the classic text and atlas on agricultural land utilization in India, Th. H. Engelbrecht: *Die Feldfrüchte Indiens in ihrer geographischen Verbreitung,* Hamburg, 1914. As a result of this interest, maps based on a variety of ratios have been constructed for India, Russian Turkestan, Western Siberia, Japan, Australia, United States, Canada, Argentina, Uruguay, and Chile. Discussion concerning these maps with numerous geographers, particularly with Professor Vernor C. Finch of the University of Wisconsin, Professor Carl O. Sauer of the University of California, Professor Derwent S. Whittlesey of Harvard University, and the members of the Department of Geography of the University of Chicago, has been of great help in suggesting ratios likely to be of geographic significance and in improving procedure in the construction of isopleth maps. The article by Ellsworth Huntington entitled "The Quantitative Phases of Human Geography," in the *Scientific Monthly,* Vol. 25 (1927), pp. 289-305, and the series of studies by O. E. Baker on "Agricultural Regions of North America," beginning in *Economic Geography,* Vol. II (1926), p. 459, are highly suggestive as to the utility of ratios and isopleth maps. At the December, 1928, meeting of the Association of American Geographers the writer presented a paper entitled "Ratios in Regional Interpretation," an abstract of which was printed in the *Annals of the Association of American Geographers,* Vol. XIX (1929), pp. 36-37. A note in the *Geographical Review,* Vol. XX (1930), p. 341, discusses the use of the word "isopleth."

Many of the points covered in this paper are considered in Max Eckert: *Die Kartenwissenschaft,* 2 vols., Berlin, 1921-1925.

part have been calculated from data applying to large areas, such as countries, or from data for small areas, such as counties, thought to be typical of large areas. A ratio thus commonly employed is that of area in all crops to total land area. Many presumably significant ratios still await discovery by geographers, or at least common use, either in tabular or in map form. Such, for example, are various ratios between different crops, and between crops and livestock or livestock products.

In recent years the employment of quantitative data on crops, pasture, livestock, and livestock products, as the basis of dot maps,[2] has proved to be of great value in revealing, in a more nearly precise way than previously was known, regional similarities and differences in density or intensity of various agricultural phenomena. The effective quantitative comparison, except in the most general way, of the data thus mapped, either within a region or between regions, is difficult, however, particularly if the maps are on different linear or different dot scales. Furthermore, ratios cannot be mapped by the dot method, and in many cases the quantitative *relation* between phenomena is much more significant than are the absolute values of the individual phenomena.

An established conviction as to the superiority for many phases of regional investigation of the isopleth map over the dot map led the writer of this paper some years ago to begin the construction of a series of isopleth maps of India, based on certain more obviously significant ratios, such as that of area in all crops to total land area,[3] and of area in one particular crop to areas in other particular crops or groups of crops, the latter ratios suggested by the " gleichgewichte linien " on the maps in Engelbrecht: *Die Feldfrüchte Indiens in ihrer geographischen Verbreitung.* The maps thus constructed revealed many facts not previously noted, or at least recognized only in a rather vague and general manner. For example, although it had been known that the proportion of the total land area under crops on the plains of Northern India was high, it was not known until the above mentioned map was made just how high this proportion was and how it varied from one section of the plains to another. Similarly, although the domi-

[2]Of the many dot maps dealing with crops, livestock, and livestock products, the series in V. C. Finch and O. E. Baker: *Geography of the World's Agriculture,* United States Department of Agriculture, Washington, D. C., 1917, was the first major contribution.

[3]Wellington D. Jones: "An Isopleth Map of Land Under Crops in India," *Geographical Review,* Vol. XIX (1929), pp. 495-496.

nance of rice over other crops in certain sections of India was common knowledge, the extent of the area over which rice led all other crops combined, as well as various individual crops, and the intensity of the lead, were very imperfectly known until certain of the maps referred to were constructed.

Studies subsequently undertaken in coöperation with Professor Derwent S. Whittlesey, involving world-wide regional comparisons in agricultural land occupance, called for quantitative knowledge of how various associated agricultural phenomena compared within given regions and from region to region. Here again the construction of isopleth maps based on published data has brought to light new or more nearly accurate regional knowledge. The several maps accompanying this paper show some of the ratios employed and illustrate some of the kinds of contributions which isopleth maps may make in regional investigation.

In the area covered by the accompanying maps (Figs. 1 to 7), there are at least four clearly different types of commercial agriculture, namely, livestock ranching, grain farming, dairy farming, and livestock farming (sometimes called " mixed farming "). In the following table associated ratios are set down for selected counties, each of which lies within a different major type of agricultural occupance in the part of the United States covered by the maps.

ASSOCIATED RATIOS IN COUNTIES SELECTED AS "TYPICAL" OF FOUR TYPES OF AGRICULTURAL OCCUPANCE, CENTRAL NORTHERN UNITED STATES, 1925.

	Livestock ranching; Natroma Co., east central Wyoming	*Commercial grain farming; Towner Co., central northern North Dakota*	*Dairy farming; Fond du Lac Co., southeastern Wisconsin*	*Commercial livestock farming; Marshall Co., east central Iowa*
Density per square mile of population on farms	0.2 (very low)	4.9 (low)	25.7 (high)	17.9 (medium)
Percent of total land area in all crops (harvested and failure)	0.4 (very low)	68.0 (very high)	54.8 (medium)	64.8 (very high)
Percent of area in all crops in				
Wheat	0.1 (very low)	45.5 (very high)	0.9 (very low)	1.1 (very low)
Corn	5.6 (low)	1.1 (very low)	22.8 (medium)	53.0 (very high)
Hay	77.2 (very high)	9.2 (low)	29.9 (medium)	17.3 (medium)
Total livestock units (horses, mules, cattle, sheep, goats, swine) per square mile[4]	13.4 (very low)	29.5 (low)	139.2 (very high)	157.7 (very high)
Total livestock units per 100 acres in all crops	476 (very high)	6.8 (very low)	39.6 (medium)	38.0 (medium)
Percent of total livestock units in				
Horses + mules	9.0 (very low)	43.7 (very high)	14.6 (low)	16.2 (low)
Cattle	30.3 (medium)	48.6 (high)	76.7 (very high)	58.2 (high)
Sheep + goats	60.6 (very high)	2.7 (very low)	0.9 (very low)	1.1 (very low)
Swine	0.1 (very low)	5.0 (low)	7.8 (low)	24.5 (high)
Gallons of milk produced annually per acre in all crops	7.9 (very low)	7.0 (very low)	115.2 (very high)	22.9 (low)

All ratios calculated from data in *United States Census of Agriculture*, 1925, Department of Commerce, Bureau of the Census, Washington, D. C., 1927.

[4] 1 livestock unit = 1 horse = 1 mule = 1 cattle = 7 sheep = 7 goats = 5 swine, as used by United States Department of Agriculture.

Inspection of the figures given in the table shows that certain ratios which run high in one county run low in another, " high " and " low " in each case meaning " in comparison with the limits within which the particular ratio varies," and that each county has a clearly different association of ratio values. Inspection both of the figures in this table and on the maps, however, shows that whereas one or more ratios may change markedly from one locality to another, others of the ratios do not necessarily change. Thus it appears that some ratios are of greater significance than others in distinguishing particular types of agriculture.

The method followed by the writer in selecting ratio values for the identification of particular types of agriculture is purely empirical. The figures on the maps are inspected in localities where field work or a study of existing literature has shown a sharp change within a short distance from the dominance of one kind of agriculture to another. Isopleths for ratio values which show marked change within these localities are then drawn over the entire area covered by the maps. Thus, on the map of gallons of milk produced annually per acre in crops (Fig. 6), the change in values from one tier of counties to another in northern Illinois is from 60 or above to 40 or below. Isopleths of 60, 50, and 40 therefore were drawn, with 25 added to show areas with very low milk production. In analogous fashion, from northeastern Colorado to southeastern Wyoming, on the map of total livestock units per 100 acres in crops (Fig. 5), the change in values is from below 15 to above 60, and from eastern North Dakota to central Minnesota the change is from below 15 to above 30. Hence, isopleths of 15, 20, 30, and 60 were drawn. On the map of percent of total livestock units in horses and mules (draft animals) (Fig. 4), the change from eastern North Dakota to western Minnesota is from above 30 to below 20, so that the isopleths of 30 and 25 were drawn. This method no doubt is crude, and probably it can be refined by the adoption of some statistical method at present unknown to the writer, but crude though it be this procedure appears to give fairly satisfactory " index figures." The following table presents the limiting ratio values thus established for four types of commercial agriculture in central northern United States, and the map (Fig. 7) shows the areas set off by isopleths based on these values, within which areas a particular type of agriculture dominates.

ASSOCIATIONS OF RATIO VALUES IN EACH OF FOUR MAJOR TYPES OF AGRICULTURE IN CENTRAL NORTHERN UNITED STATES, 1925

	Livestock Ranching	*Commercial Grain Farming*	*Dairy Farming*	*Commercial Livestock Farming*
Percent of total land area in all crops	Less than 20	Ranges from high to low	Ranges from high to low	More than 20
Crop leading in acreage, as between wheat, corn and hay	May be any one	Wheat or corn in most cases	Hay or corn	Corn or hay
Total livestock units per square mile	Less than 20 in most cases	Less than 60 in most cases	Ranges from high to low	More than 60 in most cases
Total livestock units per 100 acres in all crops	More than 30	Less than 20	More than 20	More than 20
Percent of total livestock units in horses and mules	Less than 25 in most cases	More than 25	Less than 25 in most cases	Less than 25
Number of gallons of milk produced annually per acre in all crops	Less than 25	Less than 25	More than 50	Less than 25

Note.—Limiting ratio values employed in constructing the map of Dominant Types of Agriculture (Fig. 7) are underlined.

Further investigation may show that other " critical isopleths " than those here selected can better be employed to set the limits to areas within which one of the four types of agriculture involved dominates. It is believed, however, that the general method here suggested is sound. As an illustration of the manner in which such an employment of quantitative data raises for investigation problems, the existence of which has previously been overlooked or under-emphasized, the definite mapping of a region in Illinois where commercial grain farming appears to predominate (Fig. 7) is a case in point. Comparison of the associated ratios for a selected county in this area in Illinois with the ratios for a North Dakota county, given on a preceding page, are instructive.

IROQUOIS COUNTY, NORTHERN EASTERN ILLINOIS—
COMMERCIAL GRAIN FARMING

Density per square mile of population on farms	15.5 (medium)
Percent of total land area in all crops	76.6 (very high)
Percent of area in all crops in	
Wheat	1.8 (very low)
Corn	49.5 (high)
Hay	5.9 (low)
Total livestock units per square mile	68.2 (medium)
Total livestock units per 100 acres in all crops	13.9 (low)
Percent of total livestock units in	
Horses and mules	36.4 (high)
Cattle	49.2 (high)
Sheep and goats	1.2 (very low)
Swine	13.2 (medium)
Gallons of milk produced annually per acre in all crops	10.9 (very low)

One use of isopleth maps of the sorts here shown is as a guide in the selection of small " typical areas " for detailed field investigation. A series of ratios plotted over extensive areas may save much time and money that might otherwise be spent in a preliminary field reconnaissance designed to select areas which really are "typical." Or such a set of ratios may prevent mistakes in choice where field reconnaissance is impracticable. Thus, on the basis of the knowledge that Wisconsin is in general devoted to dairy farming, one might select Adams County, centrally located in the state (Fig. 7), as a "typical area" for field study. The isopleth maps, however, reveal the fact that Adams County is not typical, since the ratios of milk produced to area in all crops (Fig. 6), and of total livestock units per 100 acres in all crops (Fig. 5), run much lower than is typical for areas where dairy farming dominates.

Another use of such isopleth maps is the determination of the approximate location of the boundaries of the large region, of which a small area studied in detail in the field constitutes a typical sample. Limitations of time preclude detailed field investigation

over an extensive region, and field reconnaissance permits the running of only a few widely spaced traverses over such a region. Isopleth maps serve a useful purpose in filling the spaces not actually seen in the field.

The construction of isopleth maps from data for small statistical divisions entails much calculation and tabulation, as well as the employment of various procedures in the choice of base maps and in the drawing of the isopleths. With a view to helping some of those who may become converts to the more extensive employment of ratios and isopleth maps in regional investigation, the author of this paper ventures to state various practices which he has found helpful.

As to the statistics from which the ratios are calculated, it is impracticable in most cases for the geographer to determine the degree of accuracy which these statistics attain. Whatever error is inherent in them is inevitably carried on into the ratios as calculated, but in not a few cases it is probable that both figures used to calculate a ratio possess about the same percent of error, with the result that the ratio is more nearly true than either of the original figures.

The first job in the preparation of a given isopleth map of any area is to find the statistical data on which the ratios are to be based. Since in not a few cases the statistics for one part of the area are published by a different country or by a different political subdivision of a country than the statistics for another part of the area, the investigator should be sure that he has the several publications containing the necessary data for all parts of the area before beginning the work of tabulation and calculation on one part of the area. Ideally the statistics for every part of the area to be covered should apply to the same year or years, but most libraries are so woefully inadequate in their collection of official statistical publications of most countries, particularly in those publications issued by political divisions of countries, that one must often be satisfied with less than the ideal. There is at present urgent need for the building up of adequate collections of statistical publications in a few libraries which will lend them to accredited investigators throughout the country.

Almost as important as the statistics themselves are adequate base maps showing the locations and boundaries of the statistical divisions, and such maps should be found before calculation of ratios is begun. Most statistical publications do not contain such

maps,[5] and one of the difficulties most frequently encountered is the finding of them. In some cases it is possible to plot the ratio values by means of towns known to be centrally located in the statistical divisions, even though the boundaries of the divisions are not shown on any map available. Base maps covering different parts of the area to be charted do not need to be of the same scale, since once the isopleths are drawn it is a relatively simple matter to transfer them from several maps of different scales, each covering part of the area, to a single map covering the entire area. Some of the maps available, with boundaries of the statistical divisions, are on a very different scale from that desired in the final map. In many such cases it is easier to plot the ratio values on the maps immediately available, draw the isopleths, and then transfer the latter to a map of the desired final scale. The available maps may be of such a character that it is not allowable to mark on them; in such a case the ratio values and the isopleths can be put on pieces of tracing paper or tracing cloth laid over the map. It should also be noted that if the final map be reduced to a considerably smaller scale than that of the original drawing, errors in original placing of isopleths are proportionately reduced.

In some cases, where data are available for several kinds of small statistical divisions, there is a question as to which of the latter to employ; for example, in the United States, counties or townships. In the case of the United States, if the final map is to be of less than a certain scale, say 1:4,000,000, it is a waste of time to make the many more calculations involved in using township rather than county data. On the other hand, if township data are available, a map of larger scale can be constructed, giving a degree of detail not possible if county data are employed (compare Figs. 6 and 8). In general, it may be stated that the statistical divisions should be small in comparison with the entire area to be mapped, but not too small. The practical test of what is not "too small" is to determine that the particular divisions under question can be shown clearly on the scale of the final map.

Some systematic scheme for tabulation of data and of ratios calculated therefrom saves much time in the long run. Sheets of paper of a size convenient for filing are desirable. Such sheets of tabulated data should be filed rather than thrown away after the maps are completed, since subsequent reference to the figures

[5]The inclusion of such maps would not add greatly to the cost of the publications. It is altogether probable that were the matter brought to the attention of the authorities issuing such publications, maps would be included in many cases.

often is desirable, and recalculation is a time consuming operation. Much time is saved in some cases by omitting in the tabulation several of the right-hand digits of long numbers, since the ratio values in most cases need not be calculated beyond the first decimal place.

Calculation of the ratios can be done much more easily by the employment of a slide rule, or of some other calculating device (such as may be found in most large libraries), than by longhand arithmetic.[6] Since calculation is one of the chief tasks in the preparation of many isopleth maps, facility in the use of some calculating device is highly desirable. All calculations should of course be checked for possible errors.

After the ratio values are calculated and tabulated, the next step is to enter them on the base map, each figure in the center of the statistical division to which it applies (Fig. 8).

Isopleths then are drawn by interpolation with reference to the figures entered on the map, in the same manner as isohyets (a kind of isopleth) are drawn with reference to rainfall station figures. In the construction of rainfall maps, however, various inferences commonly are employed, in addition to the station data, in drawing the isohyets. Similarly, in the construction of any other kind of isopleth map the employment of all well founded inferences, in addition to the ratio values, results in a map nearer reality than one drawn solely with reference to the ratio values. For example, in the case of several adjacent statistical divisions where the figures plotted run high, with surrounding divisions where the figures run low, the probability in the case of the marginal divisions with fairly high figures is that the inside portions of these areas run higher and the outside portions lower than the figure for the entire division. Knowledge that one part of a statistical division is flat plain and another hill country may justify a different placing of a particular isopleth of percent of total land area under crops than the ratio value for the statistical division as a whole would warrant. Trustworthy descriptions of unequal crop distributions within a statistical division similarly constitute a valid basis for modifying the placement of isopleths indicated by the statistics alone.

In all sorts of investigation, methods are improved by experimentation. The employment of a technique tends not only to emphasize its strong points, but to make clear its weaknesses, and

[6] A. L. Crelle: *Rechnentafeln* (Berlin, 1923) is a useful aid.

to suggest alterations. Ratios and isopleth maps, so far as they have been employed, appear to be useful tools in the regional investigation of agricultural land occupance. New and better ways of using them, however, probably will be discovered. Certain it is that they constitute no infallible guide to the discovery and interpretation of much of significance in regional study. In so far as their employment appears materially to aid such investigation, however, they may well receive more attention from geographers than has been the case in the past.

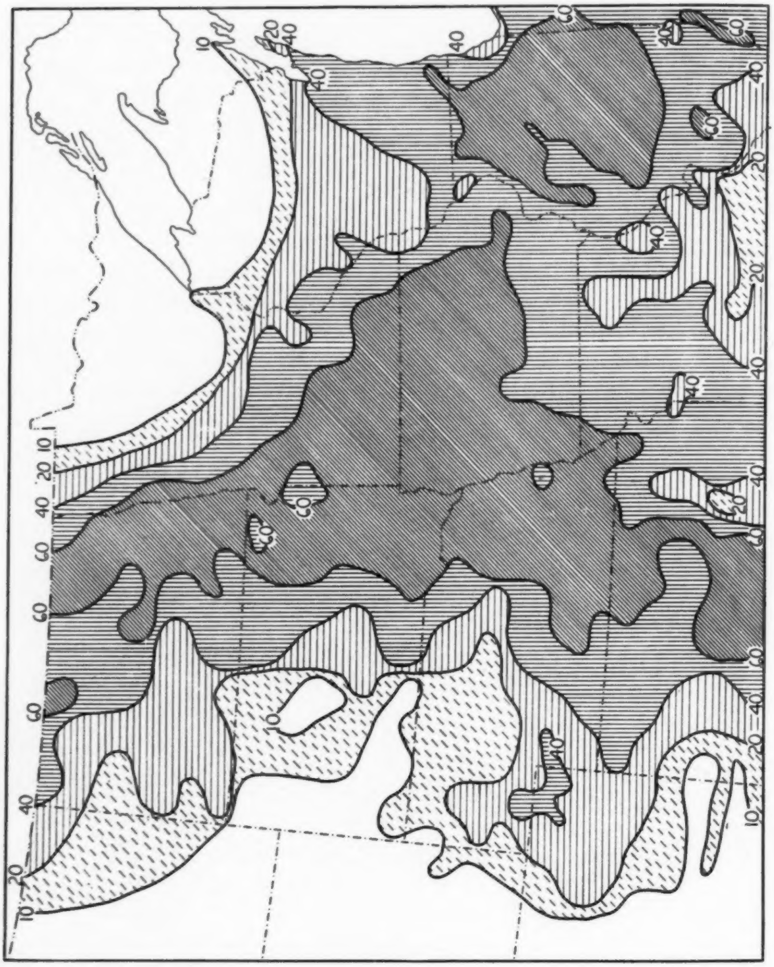


FIG. 1
Per cent of Total Land Area in All Crops (Harvested and Failure), 1925.

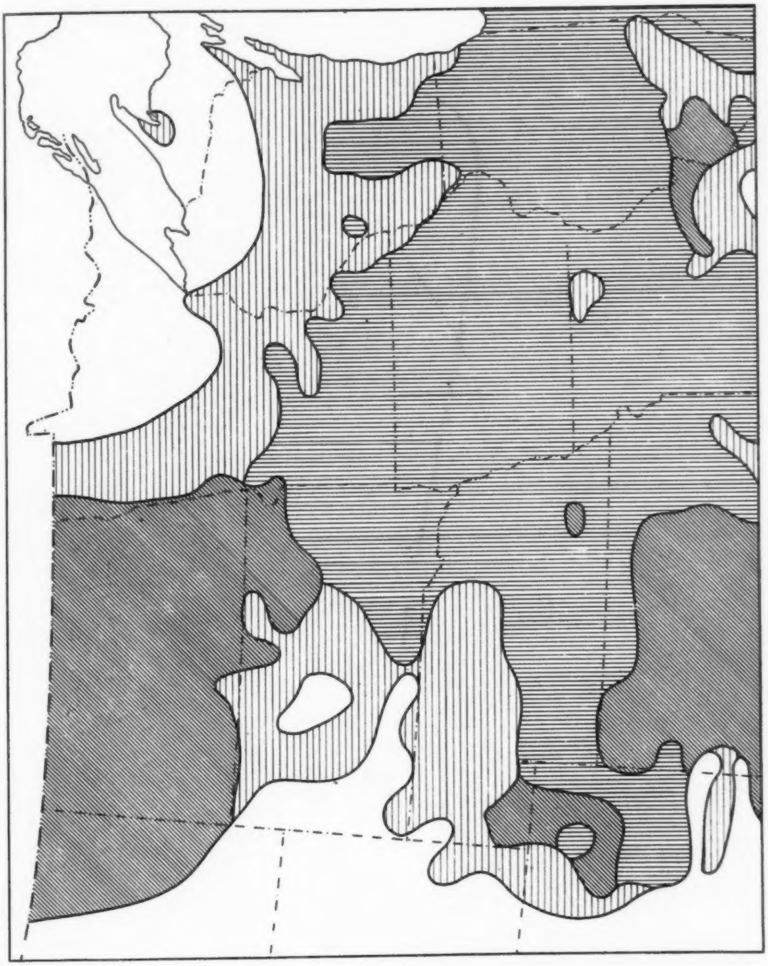


FIG. 2

Crop Leading in Acreage, as Between Wheat, Corn, and Hay, 1925.

Wheat, diagonal lines; corn, vertical lines; hay, horizontal lines; areas with less than 10 per cent of total land area in all crops, white.

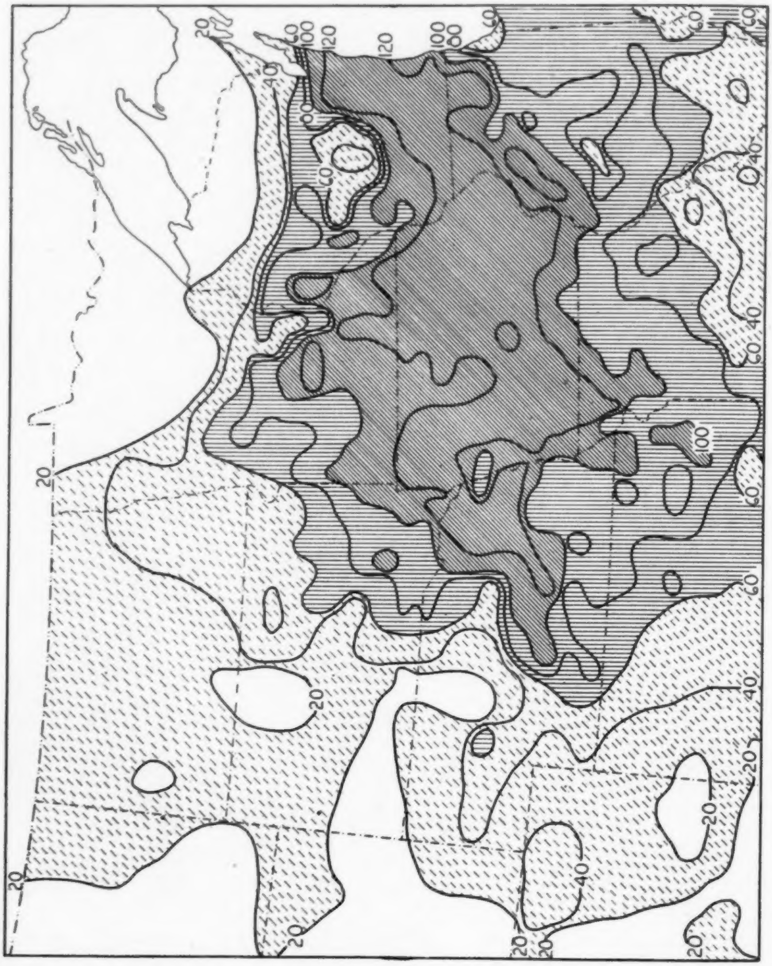


FIG. 3
Total Livestock Units Per Square Mile, 1925.

1 livestock unit is 1 horse, 1 mule, 1 cattle, 7 sheep, 7 goats, or 5 swine.

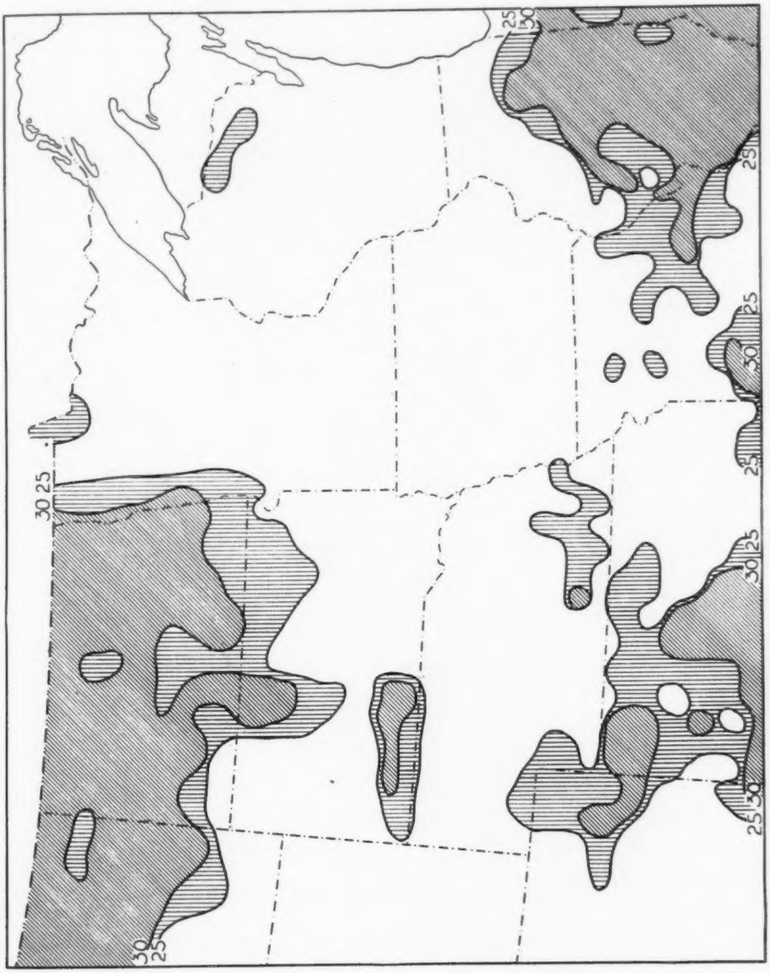


Fig. 4
Percent of Total Livestock Units in Horses and Mules, 1925.

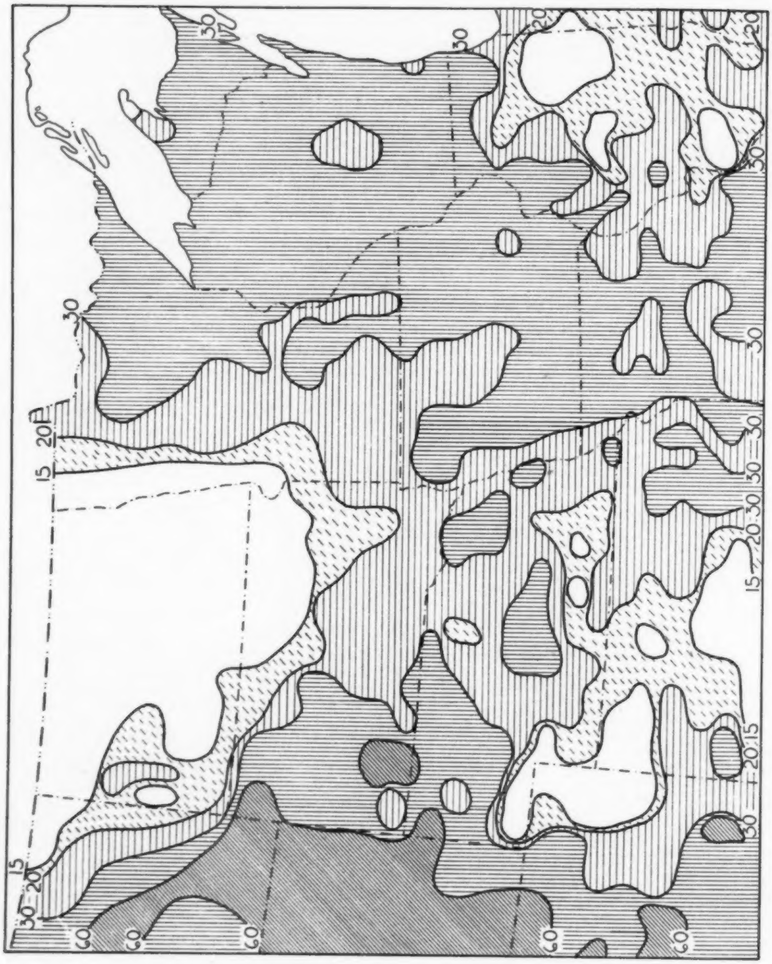


Fig. 5

Ratio of Total Livestock Units to Area in All Crops, 1925.

Isopleths show total livestock units per 100 acres in all crops.

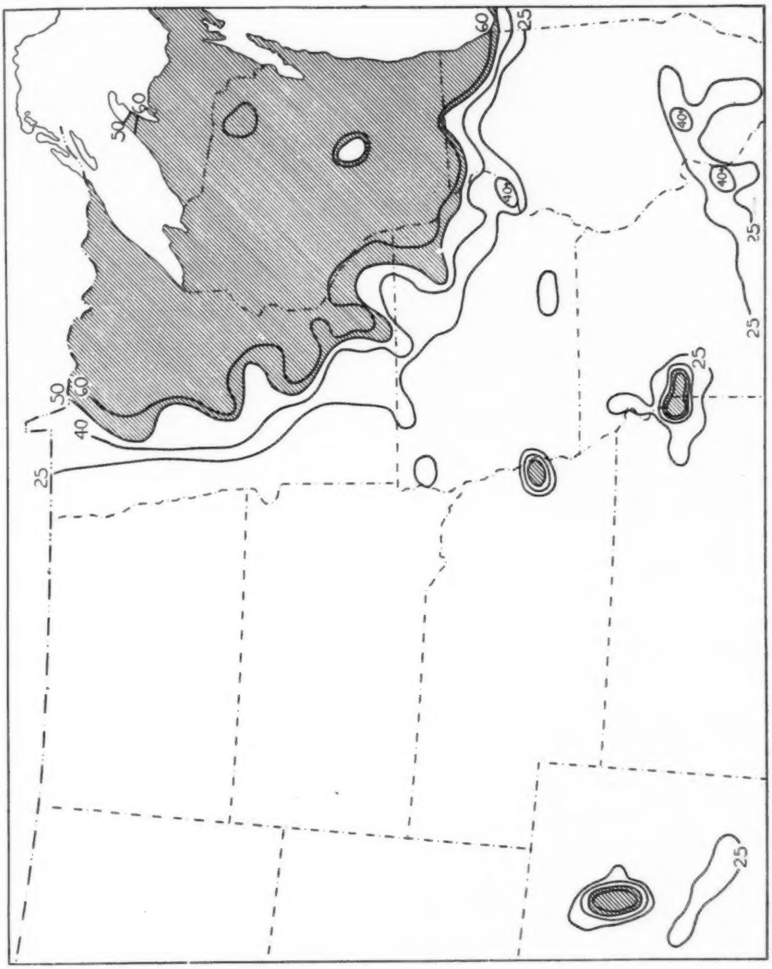


Fig. 6

Ratio of Milk Produced to Area in All Crops, 1925.

Isopleths show gallons per year per acre in all crops.

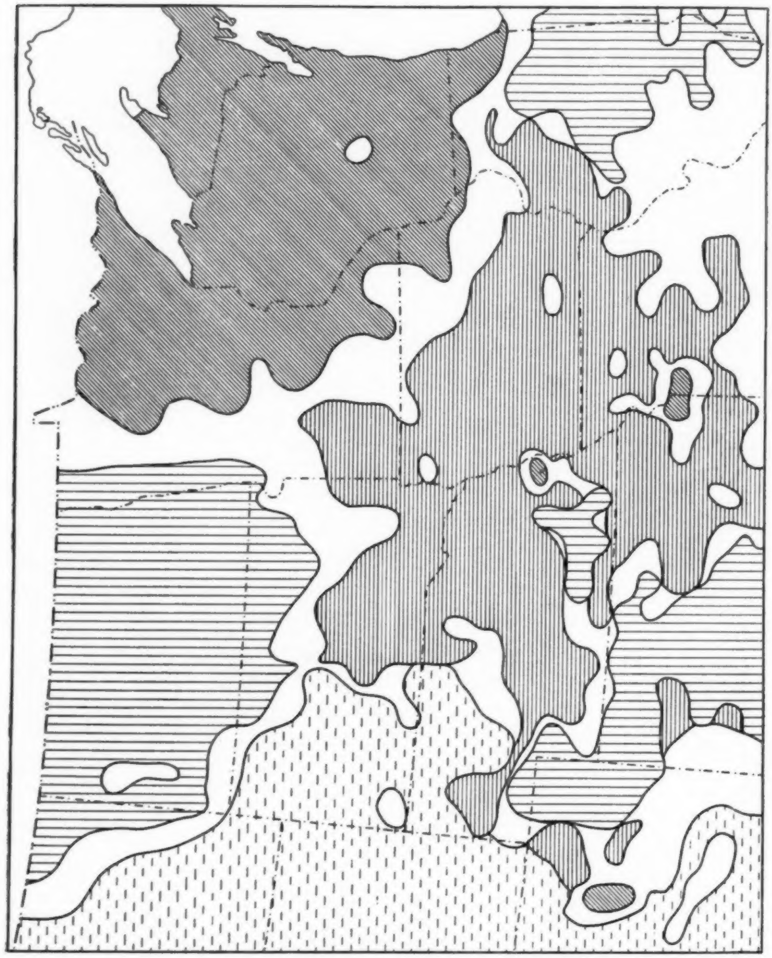


FIG. 7

Dominant Types of Commercial Agriculture, 1925.

Areas with characteristic associations of ratio values, as defined in text, are mapped as follows: livestock ranching, horizontal dashes; grain farming, vertical lines; dairy farming, diagonal lines; livestock farming, horizontal lines; transition areas of mixture, white.

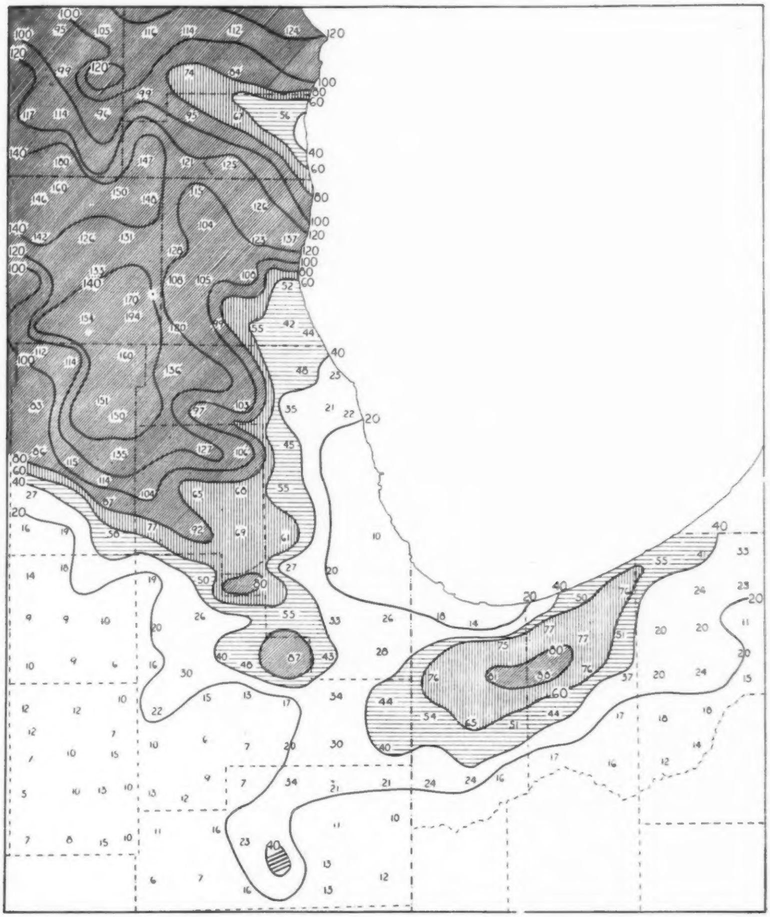


FIG 8

Ratio of Milk Produced to Area in All Crops, 1925.

Figures and isopleths show gallons per year per acre in all crops.

Township data for calculation of ratios were obtained from Edward A. Duddy: *Agriculture in the Chicago Area,* Chicago, 1929. Ratios were calculated and isopleths drawn by a group of students working under the direction of Professor Vernor C. Finch, University of Wisconsin.

The Iwaki Basin: Reconnaissance Field Study of a Specialized Apple District in Northern Honshiu, Japan

GLENN T. TREWARTHA[1]

The Iwaki Basin in far northwestern Honshiu is not without fame in Japan, for within its borders are grown 50±% of the nation's apple crop. Except for its extraordinary specialization in fruit, the basin is a representative sample of much of the Japan Sea littoral of Honshiu north of 38°; a rustic and provincial district, well removed from the great urban centers of Japanese culture and industry; a region whose citizens speak a dialect not well understood by the native of Tokyo. Thus Iwaki offers an opportunity to study traits of land occupance in a part of Nippon lying beyond the zones of tea and mulberry, two commercial crops which are so important in the agricultural economy of sub-tropical Japan.

PRINCIPAL LANDSCAPE FEATURES

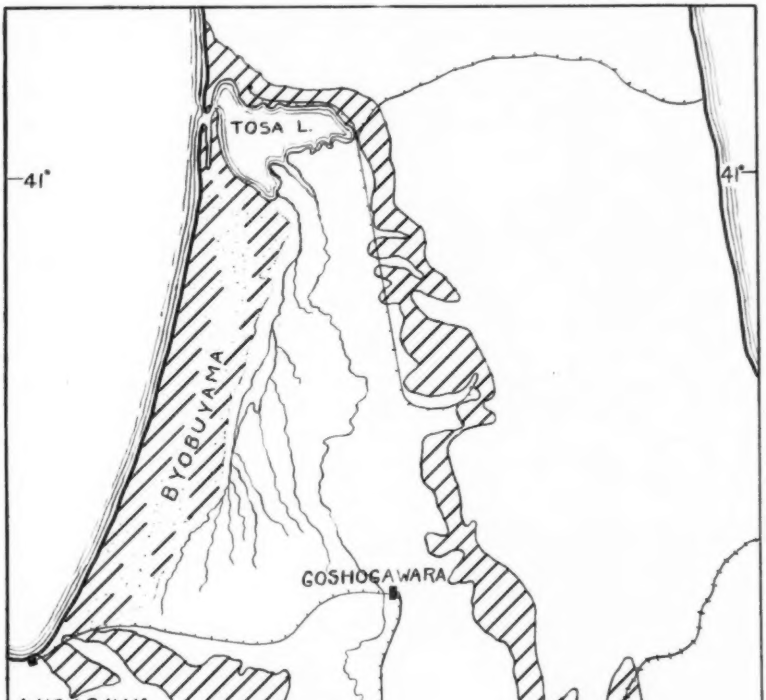
The Iwaki Valley is an alluvium-filled structural depression. So recent and incomplete is the process of filling that considerable areas in the lower end of the basin are still amphibious in character. Here lake, swamp, and paddy lands intermingle. Waves and currents have fashioned the sea margins of the plain into a smooth, harborless coast whose immediate hinterland is a wide belt of barren sanddunes and intervening swamps. Because of the peculiar shape of the basin the linear dimensions are difficult to describe, but by planimeter calculation its area is estimated to be 350 ± square miles (Fig. 1).

FIG. 1—Index map of Iwaki Basin showing lines of communication, location of cities, etc. The cross-lined area is diluvial terrace. On the small inset map of Japan, Iwaki Basin is shown in black.

[1]John Simon Guggenheim Fellow for Geographic Research in the Far East, 1926-27. This paper is the third of a series of four presenting the results of an equal number of field studies in representative rural districts of Japan made possible by the Guggenheim fellowship. Previously published papers are:

"A Geographic Study in Shizuoka Prefecture, Japan," in *Annals of the Association of American Geographers*, XVIII (1928), 127-259.

"The Suwa Basin; A Specialized Sericulture District in the Japanese Alps," in *Geographical Review*, XX (1930), 224-244.



TOSA L.
41°
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BYOBUYAMA
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The level alluvial floor of the basin is monopolized to a high degree by tiny irregular paddy fields. Only adjacent to villages and on the more irregular lands close to the river channels do unirrigated crops of vegetables, grains, and apple orchards displace rice. Numerous agricultural villages dot the valley floor while Hirosaki, the metropolis, a city of 35,000, occupies a strategic terrace site at the upper end of the basin. Surrounding the alluvium on all sides, except toward the northwest where it fronts upon the sea, are hills and low mountains of sufficient height to make the valley inhabitants conscious of their isolation. Railroads pierce the watersheds by tunnels to the east and south at elevations of 108 and 258 meters respectively, but they lead to no extensive and productive plains immediately beyond which might react favorably upon Iwaki. The western mountain barrier is more formidable, the symmetrical ash cone of Iwaki Volcano reaching a maximum elevation of 1588 meters. This height is effective in breaking the full force of the raw cold gales of monsoon origin from off the Sea of Japan which fill the valley with deep snow during the winter season. The only exception to the prevailing cover of woodland and wild grasses which mantles the hill slopes are the apple orchards which occupy considerable areas on the lower foothills.

Intermediate between the hill lands and the alluvial valley floor and completely encircling the alluvium, even along its seaward margins, are low terraces of older alluvium, in Japan designated as "diluvium." Into these unconsolidated fan and flood-plain deposits, rivers have incised their channels so that irrigation is difficult and rice is usually of small importance. A veneer of infertile volcanic ash covers much of the terrace land and provides a relatively unattractive soils environment for the orchard, grain, and vegetable crops in which the diluvial lands are specialized.

GEOGRAPHIC UNITS OF THE IWAKI BASIN

Major contrasts in site and land-use lead to a differentiation of three geographic units:

1. The Valley Floor, Mainly Irrigated
2. The Terraces and Foothills of Unirrigated Agriculture
3. The Uncultivated Higher Hill Lands and Low Mountains

THE VALLEY FLOOR

Irrigated Lands.—In Iwaki Basin, as in other parts of Japan, the unleached fresh alluvial soils are emphatically the centers of human occupance. Evidences of this gravitation toward alluvial

lands are to be observed in the greater intensity and completeness of their cultivation and in the closer spacing of rural villages on their surfaces. The greater abundance of culture forms upon the fresh alluvium than elsewhere not only reflects the superior fertility of these sites but in addition emphasizes the almost universal rice diet of the Japanese and the general poverty of Nippon in lands of slight relief suitable for this pampered irrigated crop. The population of the valley is predominantly agricultural, and rural villages of a few score, or possibly hundred, houses are the principal units of settlement. Customarily farmers in Japan do not live on their farms but reside in villages, going back and forth between their homes and the tiny scattered field plots in the immediate countryside. The usual pattern of a Nipponese village is distinctly linear in dimensions, with the closely spaced homes and places of business strung out along a highway which also serves as the main, and often the only, street of the town. By such an arrangement less of the valuable paddy land is made unproductive by confiscation for street and house sites. In addition, difficult and expensive hard-road construction is thereby reduced to a minimum.

In spite of the more severe climate the flimsy type of frame or mud-plaster residence, with steeply-pitched thatch or tile roof, common also to sub-tropical Japan, is almost universal in Iwaki. The charcoal " hibachi " is the only means of home heating. The one very obvious feature of village planning and house construction directly related to this more severe northern climate, notably the heavy snowfall,[2] is the covered sidewalks (Fig. 2). In the majority of Japanese villages, houses and shops are flush with the street gutters, so that pedestrians travel the same routes as the vehicles and beasts of burden. In these northern towns there is frequently a pedestrians' walk between the street gutters and the buildings, the walk being covered by the wide projecting eaves of

[2] No meteorological data of a reliable nature are available for Hirosaki, and quantitative measurements of snowfall or depth of snow cover do not exist for any Japanese stations. Hirosaki, however, lies between Akita on the Japan Sea coast and Aomori on Aomori Bay to the north and at these cities there are on the average 105.7 and 92.2 days with snow respectively during the year and 16.4 and 17.2 inches of precipitation during the three winter months (10 ± inches of snow are equivalent to an inch of rain). Since both of these stations have more than 20 days of snow during each of the winter months, it is certain that a large part of the cold season precipitation (16-17 inches) is in the form of snow resulting in a deep snow cover. The interior location of Hirosaki probably reduces its snowfall somewhat.

the houses. In winter, storm windows are set up at the outer edge of the eaves so that the walks are entirely enclosed and protected from drifting snow. The writer was told that in Hirosaki the accumulated snow in the streets becomes so high before the end of winter that from the covered sidewalks one can see vehicles and horses passing by outside at waist or shoulder level.

In the better protected upper part of the valley under the lee of Iwaki Mountain, where the amount of swamp is less and where proximity to Hirosaki assures of better marketing and transportation services, the population density reaches its maximum, averaging 300-500 per square kilometer (780-1300 per square mile) (Fig. 3). In the basin's medial latitudes this declines to 200-300

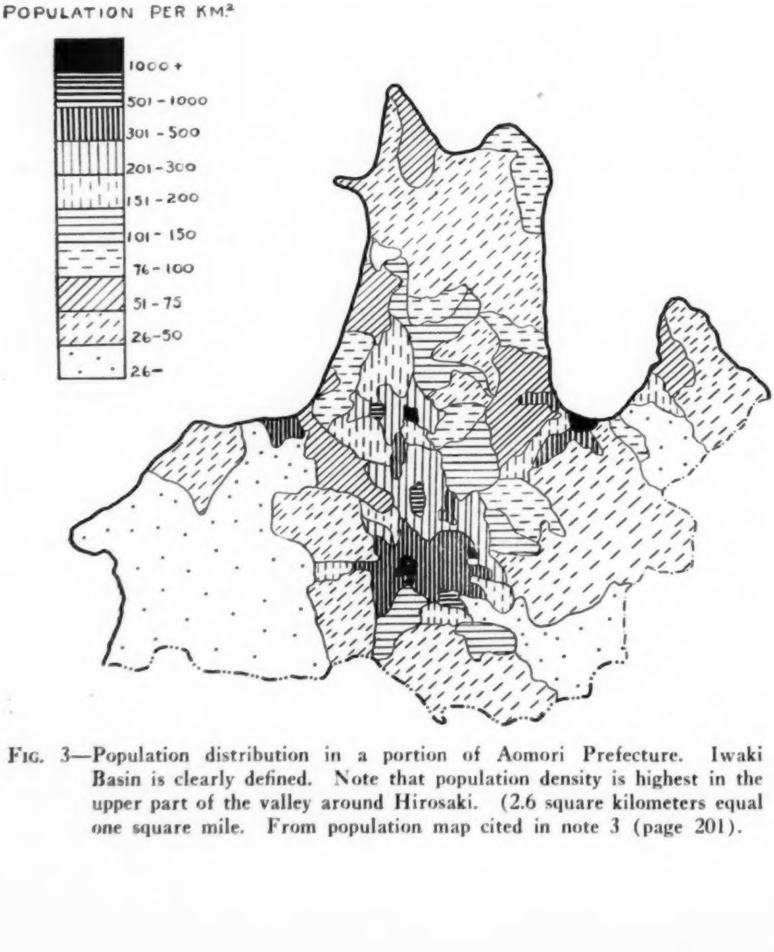

FIG. 3—Population distribution in a portion of Aomori Prefecture. Iwaki Basin is clearly defined. Note that population density is highest in the upper part of the valley around Hirosaki. (2.6 square kilometers equal one square mile. From population map cited in note 3 (page 201).

FIG. 2—A street in Kuroishi. Note the steep thatched roofs of the buildings with the wide eaves projecting out over the sidewalks. This latter characteristic is a precaution against the heavy snows.

per sq. km. (520-780 per sq. mi.), and is ultimately reduced to 150-200 per sq. km. (390-520 per sq. mi.) at the northern end (excluding the outer belt of swamp and sand).[3] These densities while relatively high for northern Japan are not equal to those of more southerly latitudes, parts of the Kwanto or Tokyo Plain supporting populations of 1300-2600 per sq. mi. The decrease in population from south to north in Japan may be interpreted largely in terms of the latter's less genial and hospitable climate. The cold snowy winters (Hirosaki on extreme southern margin of Dfa climate according to Köppen) of Hokkaido and northern Honshiu make living hard for the warmth-loving Japanese whose dwellings are flimsy and poorly heated. The shorter growing season and more severe winters largely exclude tea and mulberry which are such significant upland cash crops in the warmer latitudes. Rice cultivation is made more difficult by the frost-free season of only 5-6 months and winter cropping is less profitable.

[3]H. Tanakadate, Y. Tomita and H. Saito: *Distribution of Population in Northern Japan,* with map, 1:800,000. Sendai, Japan: The Saito Gratitude Foundation, 1926.

In an alluvial region of inundated paddies such as Iwaki, roads must be elevated as well as surfaced. However, an abundance of assorted gravels in the never-far-distant terraces, materially lessens the costs and difficulties of highway construction. The macadam surfaces are often far from being well dressed and smooth, but this handicap is not serious since they are used almost exclusively by slow-moving traffic. The main highways converge upon Hirosaki in the southern end of the basin. In the lower valley where swamp land is prevalent, the two main roads follow along the eastern and western margins adjacent to, or even on, the low terraces where the land is higher and better drained. In winter when deep snows cover the valley, sleighs become the almost exclusive vehicle for transport on the highways.

Only the southern part of the valley is well served by railways. Hirosaki is on the main government line which connects Aomori, the principal seaport of northern Honshiu, with the Japan Sea coast. As previously stated this line passes the mountain barriers on the east and south only by means of tunnels. A secondary narrow-gauge line runs northward down the middle of the basin to Goshogawara and from thence westward to Ajigasawa on the Japan Sea coast. A still more diminutive railway parallels the extreme northeastern margin of the valley, and makes contact with the port of Aomori.

To the eye the floor of the basin is essentially flat. Throughout most of its length the average gradient toward the sea is not far from one meter per mile, becoming somewhat less toward the lower end. Both because of the slight gradient and also the formidable belt of dune-capped terrace which blocks the sea-end of the valley, lake and swamp are prevalent. It appears that vigorous waves and longshore currents which have been partially responsible for the obstruction at the mouth of the valley, have succeeded in pushing the outlet of the Iwaki River far to the north. At present it flows 6 to 8 miles farther than necessary as measured by the shortest distance to the sea. Finally it debouches, not into the ocean, but into Tosa Lake, a still unfilled section of the basin, at present almost cut off from the sea by advancing spits.

Irrigated paddy lands have pretty much the same appearance everywhere in Japan and the Iwaki Valley is no exception to the rule (Fig. 4). The tiny irregular fields, tennis court in size, each plot surrounded by its diminutive dikes, perhaps a foot in height and equally wide, is the characteristic pattern of cultivation. The march of the seasons brings with it a succession of

FIG. 4—A small rural village in the midst of inundated paddies. Apple orchards cover the slopes in the immediate foreground.

changes in the face of the plain.[4] June sees the paddies like glistening mirrors, as the young plants are set out in the flooded fields. In summer when the crop is full grown the individual field plots are still distinct, as they are set off from one another by the interruptions at the unplanted dikes. After harvest the swampy, stubble-covered paddies look shorn and desolate.

The Iwaki Basin is somewhat unusual in that rice is here produced in such abundance that it has become the chief commercial crop. The straw bundles filled with rice which one sees at railway stations awaiting shipment are evidence to this condition (Fig. 5). Japan as a nation, however, is an importing region. Iwaki's excess production of rice seems still more unusual when one considers that climatically these northern locations are less satisfactory for rice than are the more southerly latitudes where growing seasons are longer, summers hotter, and warm-season rainfall heavier. (See Table I comparing meteorological data for $\frac{\text{Akita} + \text{Aomori}}{2}$ with Tokyo, 5° farther south).

[4] A more complete and detailed seasonal cross-section can be found in Trewartha: "A Geographic Study in Shizuoka Prefecture, Japan," *op. cit.*, 217-221.

TABLE I

Meteorological Data for $\frac{Akita + Aomori}{2}$ and Tokyo

Station	Average Temperature of Coldest Month	Average Temperature of Warmest Month
1. $\frac{Akita + Aomori}{2}$	28.0	73.8
2. Tokyo	37.4	77.0

	Mean of Daily Min. Temp. for January	Mean of Daily Max. Temp. for July
1. $\frac{Akita + Aomori}{2}$	22.1	77.5
2. Tokyo	29.5	85.6

	Frost Free Season	Days with Snow	Hours of Sunshine		
			July	Jan.	Year
1. $\frac{Akita + Aomori}{2}$	175 days	99	170.	49.	1662.
2. Tokyo	220 days	13	182.9	187.3	2124.0

	Amount of Precipitation in Inches		
	July	Jan.	Year
1. $\frac{Akito + Aomori}{2}$	6.7	5.6	63.07
2. Tokyo	5.6 (6.6 in June)	2.2	61.89

As a consequence of its more rigorous climate, Iwaki specializes in a hardy, quick maturing variety of rice. This accommodation has not been made, however, without a compensatory sacrifice in yield, estimated at 20% less than in middle and southern Japan.[5]

The per unit area yield of food from this northern plain is further reduced by the inability to grow winter crops on the plots

[5]Information obtained through conversations with officials in Agricultural Experiment Station at Kuroishi.

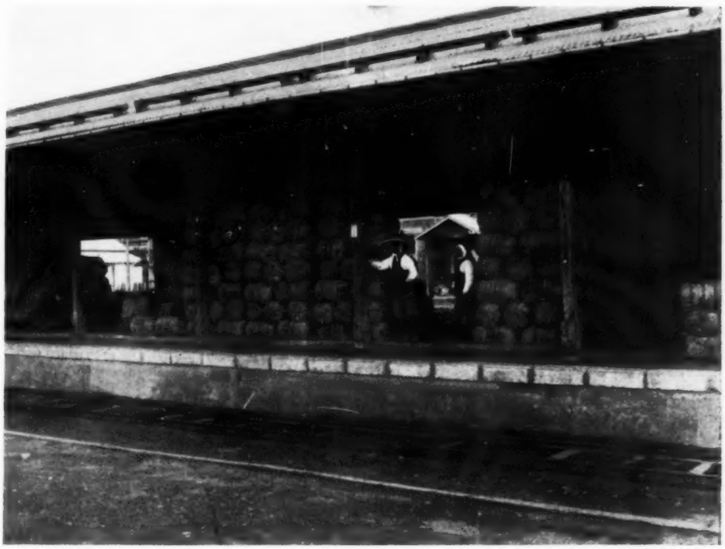

FIG. 5—Straw bags containing hulled rice at Kuroishi station awaiting shipment out of Iwaki Basin.

from which rice has been harvested. Over Japan as a whole 30-40% of the paddy area is replanted to a second crop in winter, usually wheat, barley, or rape. But in the Iwaki Valley rice occupies so much of the growing season that the frost-free period in autumn is scarcely long enough for the sprouting of winter grains. Moreover the heavy cold-season precipitation prevents the inundated paddies from being made and kept sufficiently dry to allow the unirrigated grains to prosper.

The alluvial soils of the Iwaki Plain in general vary from sandy loams to clay loams. The heavier soils, which are more difficult to work when inundated, are the most productive and require the least fertilizer. On the other hand the soils with a higher content of sand, although less fertile, are scarcely less popular because of the greater ease with which they can be handled when wet.

The master stream of the Iwaki Basin, unlike most delta-plain rivers in Japan that the writer has observed, flows in a relatively narrow and incised channel 10-20 feet below the general plain level. To prevent lateral migration of the river, bamboo baskets filled with stones, together with log barricades, protect the outer

banks of meander curves. Because of the incised channel, irrigation from the main stream is made difficult, so that water for the paddies must be taken either from the principal channel at a point far back along its course, or what is more usual, from the less remote, unentrenched parts of minor streams. Along the eastern and western margins of the basin, water for irrigation is obtained from artificial lakes formed by damming the creeks in the low diluvial terraces.

Unirrigated Riverain Lands.—The impression one gets from traveling the highways of the Iwaki Basin is that there is a larger percentage of land devoted to unirrigated crops than is actually the case. This somewhat exaggerated idea of the importance of non-paddy land is a natural consequence of the localization of dry crops, (a) adjacent to villages which in turn parallel the highways, and (b) more especially along the main stream courses which, in the upper part of the valley at least, are common sites for highways and villages. Proximity to the farm home offers

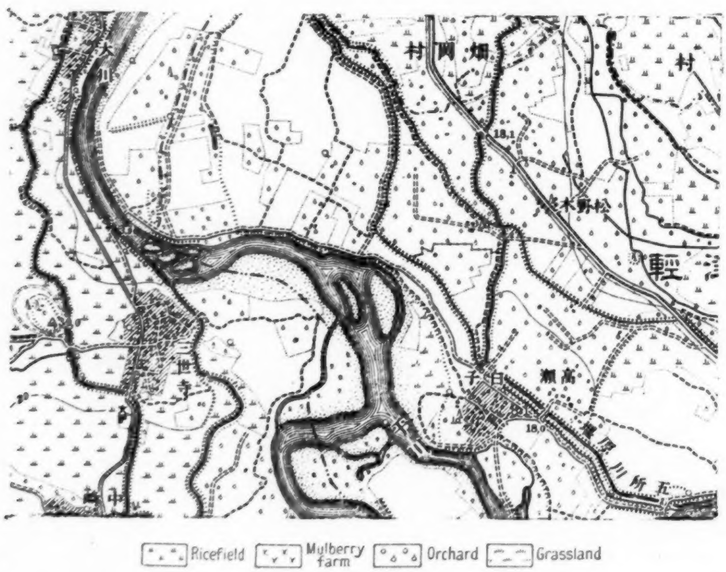

FIG. 6—A section of the riverain belt showing the prevalence of apple orchards and other unirrigated crops of grain and vegetables. Grain and vegetable areas are left blank on the map. Japanese Army Survey Map, scale 1:25,000.

the advantage of greater protection against pilfering. It is likewise of genuine benefit to have such crops as potatoes and apples near highways and not separated from the village by several hundred yards of inundated paddies across which transport is no easy matter.

By far the largest areas of contiguous dry fields on the fresh alluvium are along the principal stream courses (Fig. 6). In such locations unirrigated crops are the rule rather than the exception. The riverain dry-crop belt is extremely variable in width, never totalling more than a mile even along the trunk stream and usually not exceeding one-half mile. This variation from the usual rice monopoly of the alluvial lowland chiefly reflects the greater irregularity of the land surface in close proximity to the rivers. The terrain is scarcely rough, but it is scarred with relict forms of old stream channels, river terraces, and fossil meander curves still exhibiting mild slip-off slopes and steepened outer embankments. In such a region of uneven surface the leveling of the land which is necessary for an inundated crop like rice, and the construction of complicated irrigation systems to flood the various surface levels, would involve a large expenditure of labor and money. On the other hand slope sites are an advantage for dry crop agriculture since adequate drainage is assured. The lighter sandier soils of the riverain lands are a factor of secondary importance making them attractive for vegetable crops, especially tubers. Light sandy loams with porous gravelly subsoils seem to be most prevalent in the riverain division, but in places loamy sands prevail. Even in a region of such abundant snow these light soils dry out and become warm early in the spring, thereby allowing early planting and sprouting. The difficult, abundant and distasteful work associated with rice cultivation normally makes it an unpopular cash crop, so that farmers are not at all loath to turn to vegetables or fruit which require less expenditure of energy and often yield a higher cash return. A variety of crops characterizes the agricultural set-up of the riverain lands. In June, when the writer was making field observations, apple orchards, potatoes, and rape seemed most in evidence. Significant of Iwaki's latitudinal location is the importance of the potato and apple crops, forms of cultivation either unknown or unimportant on the plains of middle and southern Japan. Beans, millet, buckwheat, and vegetable crops (yams, burdock, onions, daikon, etc.) at one time of year or other enter into the rotation system (Fig. 7). There seems to be no purposeful arrangement of the crops

FIG. 7—Unirrigated crops of rape and vegetables together with apple orchards on the riverain belt near Fujisaki.

with respect to site. Unlike the situation in central and southern Japan these unirrigated lands of the north are not usually subjected to an intensive multiple cropping. One crop a year is common; three in two years is probably more so. A much practiced rotation of the latter type is as follows: Potatoes are planted in spring and harvested in early fall; rape follows as a winter crop and is harvested the following summer, while a bean crop, intercultured with rape, matures in autumn. Data are not available by which to determine what percentage of the Iwaki apple crop is grown on the alluvial valley floor as compared with the diluvial terraces and the lower hill slopes, but probably there are more trees on the alluvium than on the foothills although not so many as on the terrace lands. Where the writer has seen them, the riverain orchards appear to be of smaller dimensions, or at least contiguous over less extensive areas, than on the terraces and the foothills. Scattered orchard plots, up to a few acres in size, are the rule near the river.

The fields growing crops of annuals are, except on irregular surfaces, largely rectangular in shape but of various areas and di-

mensions. On the whole they are somewhat larger than is normal in the warmer latitudes of Japan, but even so a fraction of an acre is most common. Occasionally the patches of potatoes may exceed an acre (Fig. 8). Like apples, potatoes are an export

FIG. 8—A relatively large patch of potatoes in the riverain zone near Fujisaki.

crop, Aomori Prefecture holding first rank in Japan after Hokkaido as a producer of this tuber. Out of the 468,604 kan[6] shipped beyond the boundaries of the prefecture in 1925, chiefly to central and southern Japan, the Iwaki Basin was responsible for 338,000 kan or 72%.[7] It is largely the cooler summers of northern Japan with less precipitation which makes it a superior potato country to humid sub-tropical Japan.

THE TERRACES AND FOOTHILLS OF UNIRRIGATED AGRICULTURE

By reason of their poverty in rice cultivation and their specialization in unirrigated crops, these more elevated lands possess geographic unity in themselves, and at the same time are set apart from the alluvial plain. Physically, because of steeper slopes and

[6]Kan=8.267 pounds.

[7]*Abridged Statistics of Agriculture in Aomori Ken,* 1925, 48-49. Aomori, Japan: Aomori Prefectural Office.

thinner soils, and culturally because of less complete utilization, the foothills may be distinguished from the diluvial terraces.

The Diluvial Terraces.—The belt of terrace which encircles the alluvial paddy lands and forms an intermediate step in elevation between them and the low mountains, is the remnant of a more ancient alluvial floor which previously covered the basin. Subsequent uplift and erosion have resulted in the entrenching of the streams and the removal of much of the earlier alluvial surface except along the margins of the basin. More recently new floodplain deposits have been superimposed upon this erosion surface.

The terrace belt varies from place to place in width, elevation and composition. In the upper end of the valley near Hirosaki it is two to four miles wide and 100-150 feet in elevation, but widths of a mile or less and elevations of 10 to 50 feet are more usual. The descent from terrace to alluvial floor is commonly abrupt, sometimes even an escarpment several meters high. Where the latter condition prevails there is a sharp "geographic uncon-

FIG. 9—Three typical landscapes of Iwaki Basin are here in evidence. In the foreground are inundated paddies typical of occupance on the new alluvium. In the middle distance is a section of low terrace planted to apple orchards, while in the distant background are the hill lands.

formity " separating the paddy lands at the lower level from the unirrigated crops on the terrace above (Fig. 9). In some places the transition from alluvium to diluvium is so gradual that the exact point of juncture is difficult to determine. Similarly the contact of diluvium with mountain foothills is in places sharp and abrupt, in others gradual and not easily noted. Portions of the terrace have been so thoroughly dissected that only numerous isolated remnants remain, these standing out as islands physically and culturally above the inundated paddies (Fig. 10). Occasionally

FIG. 10—In the foreground is a hill slope apple orchard. In the background fragments of terrace covered with woods, orchards and unirrigated annuals stand out like islands in the midst of inundated paddies.

spurs and outliers of the hill lands, surrounded by diluvial sediments, rise prominently above the terrace level. These commonly bear a woodland or orchard cover.

The flat to moderately irregular surfaces of the uplands provide a slope environment in which cultivation is relatively easy. In places the regular and crescentic arrangement of the contours indicates fan formations. The materials composing the terraces are assorted clays, sands, and gravels. Commonly the upper sediments have a large addition of volcanic ash which develops into

a fine, powdery, clay soil. These ash soils are not fertile, being acidic and lacking in lime and phosphorous. The virgin soils of the terraces are frequently hard and compact, and because of the abundance of finely divided iron particles they have a distinct yellowish-red appearance.[8] Where the soils have been under cultivation for some time the surface soil is remarkably black. The subsoils are variable in composition. A vertical cut of about 20 feet near Hirosaki exhibited a succession of clay, sand, and gravel strata. This was repeated in a number of other shallower cross sections seen in various parts of the basin, with a clay stratum usually at the top.

The somewhat uneven surfaces of the uplands, their frequently heavy upper soils, and most of all the incised nature of their streams, react against the use of the terraces for irrigated rice. Along the floors of the valleys cut back into the uplands the tiny irregular diked paddies provide the common pattern of cultivation. In places so much of the upland has been removed that large contiguous areas of diluvium no longer exist and there prevails an intricate intermingling of alluvium and diluvium, and consequently irrigated and unirrigated crops. Many of the small valleys do not carry permanent streams, so that irrigation is often from artificial ponds made by damming natural depressions which collect and preserve the surface runoff. The uplands in their utilization forms are not unlike the riverain zone in many ways. Apple orchards, vegetable crops and rape were the crops most in evidence in June. On the extensive terrace lands southwest of Hirosaki there are to be seen the largest areas of contiguous apple orchard anywhere in Iwaki Basin. From a certain vantage point one can look out over scores of apple orchards with scarcely a break in the continuity of cultivation. Here and there are to be seen small thatched sheds and houses rising above the orchard level, these being used as storehouses for implements and as temporary residences for the workers during busy periods of sacking, spraying, and picking. Narrow, unsurfaced, rutted roads intersect the orchard lands. In general terrace soils are less porous and less fertile than is the alluvium along the stream courses and are therefore not as satisfactory for vegetable culture. Two crops, tea and mulberry, common to the uplands of

[8] These are the "burozems" (brown soils) in the Russian classification. See Mikhailovskaia, O. N.: "On the Soils of Japan." Academy of Sciences of the U. S. S. R.: *Contributions to the Knowledge of the Soils of Asia*, No. 1 (1930), 9-30.

subtropical Japan are lacking here, the climate being so severe as to place the Iwaki Valley well outside the tea zone and just beyond the northern edge of mulberry cultivation.

Strange to the eyes of an Occidental, who is well taught concerning the overcrowded condition of Japan and the consequent intensiveness of its agriculture, are the considerable areas of flat to moderately sloping terrace land uncultivated and almost unutilized (Fig. 11). Some of it bears a cover of small scrubby

FIG. 11—A portion of the level terrace surface southwest of Hirosaki covered with a turf of coarse grass and ferns.

trees, these being cut for fuel—sometimes converted into charcoal. Other areas are covered with a turf composed of coarse wild grasses and ferns, largely waste, although some is cut for horse feed. To the south of Hirosaki, which is a military center, there are large, relatively level areas of the upland surface occupied by troop barracks and used as drill fields. In many instances the writer was told that the uncultivated portions of the upland were communal lands, property of the villages whose citizens are permitted to cut fuel and grass from them. No doubt the infertility of the terrace soils is a direct cause for their incomplete utilization. In addition it must be reëmphasized that in a country where rice is

the universal food, occupying more than 50% of the cultivated land, those locations not suited to rice are held in much lower esteem and consequently they have been brought into use at a relatively slow rate.

The metropolis of the valley, Hirosaki, a city of 35,000 inhabitants, occupies a strategic position on a high prong of terrace and the adjacent plain at the convergence of several valleys in the upper end of the basin. On a commanding site 47 meters high, overlooking the fertile basin floor, is the splendid moat-protected castle, a relic of feudal days when a daimyo ruled at Hirosaki. It is about this castle as a nucleus that the city has grown. A public park occupies a portion of the castle grounds which looks out over the valley toward the majestic cone of Mt. Iwaki while considerable space is given over to military barracks. The city serves as the assembling and distributing point for the productive valley, the radial pattern of the converging roads and rail lines reflecting its use-function to the surrounding service area.

The diluvium in the northern end of the valley is less completely utilized than that farther south and nearer to the metropolis. This reflects in a measure at least the more exposed nature of the lower valley, which is not protected by Mount Iwaki and so receives the full brunt of the strong winter monsoon. It is further handicapped in being near the lower end of a blind valley which makes no use of the seaway, and on the perimeter of the local transportation system which is focused at Hirosaki. The areas of scrub timber and wild grasses become more extensive on the uplands farther north, while apple orchards are much less in evidence. Occasionally one finds new and isolated farm homes with adjacent cultivated plots which have only recently been reclaimed for agricultural purposes. In some respects these have earmarks of frontier outposts. Numerous artificial lakes, averaging several scores of acres in size, the waters of which are used chiefly for irrigating paddies on the adjacent alluvium, are a characteristic feature of the terrace lands in the lower valley. The lakes are very irregular in outline and dendritic in pattern, their basins having been originally the shallow valley systems of wet-weather streams. Cheaply constructed earthen dams at the lower ends of these natural basins are all that is necessary to transform them into suitable irrigation reservoirs, whose waters can by gravity be brought to the alluvial paddy lands which lie at a lower elevation. The principal highways and villages are located along the extreme outer edge of the terrace where it meets the alluvial floor of the valley.

This location has a dual advantage, for it not only offers better drained sites than does the swampy valley floor, but a village thus situated is intermediate in position between terrace and new alluvium, thus making the farm plots on each readily accessible.

Byobuyama.—The extreme lower end of the valley where it borders on the sea is terminated by a strip of relatively unproductive and desolate land nearly four miles wide and rising 20 to 50 meters above the alluvium. The geological map indicates this strip to have a base of diluvium upon which has been superimposed a veneer of sand and sand dunes, which nearly mantles the terrace material. Elongated east-west dunes occupy large areas along the seaward side of the terrace, the inner margins having a less irregular surface. Lakes and swamps are numerous. The smooth, precipitous, wave-cut coast line is entirely without settlements. A mantle of scrubby trees and wild grasses covers much of the surface, for only along the inner margins has there been any attempt to bring portions of the land under cultivation. A principal highway with villages along its route follows the landward edge of Byobuyama. The smooth, harborless littoral, together with the belt of relatively barren land immediately back of it, shutting the valley away from the sea, have been important factors in discouraging the inhabitants of the Iwaki Basin from utilizing the sea way.[9]

THE APPLE INDUSTRY

Since apple orchards are not confined to any one of the geographic subdivisions, but are an important crop in all of them, it is proposed to treat the fruit industry as a unit.

The entire apple crop of Japan is grown in the cooler higher latitudes or high altitudes of that country. The outstanding center is Aomori Prefecture in northern Honshiu with 59% of the total crop (by weight) and Hokkaido with nearly 27% (Fig. 12). Nagano, a high-altitude mountainous subdivision in central Honshiu, follows next in order with 6% and Akita in northwestern Honshiu with 4%. All other prefectures have less than 1% each.[10] Of the 59% of the apple crop credited to Aomori Prefecture, all but 10-15% is grown in Iwaki Basin, so it seems certain that one-

[9]The name Byobuyama is from two Japanese terms, "byobu," meaning "a protective screen," and "yama," a mountain. Thus the very name of this landform recognizes its barrier effect.

[10]Department of Agriculture in Japan, *The Truck and Fruit Industry of Japan*, 1927 (in Japanese), 36-37.

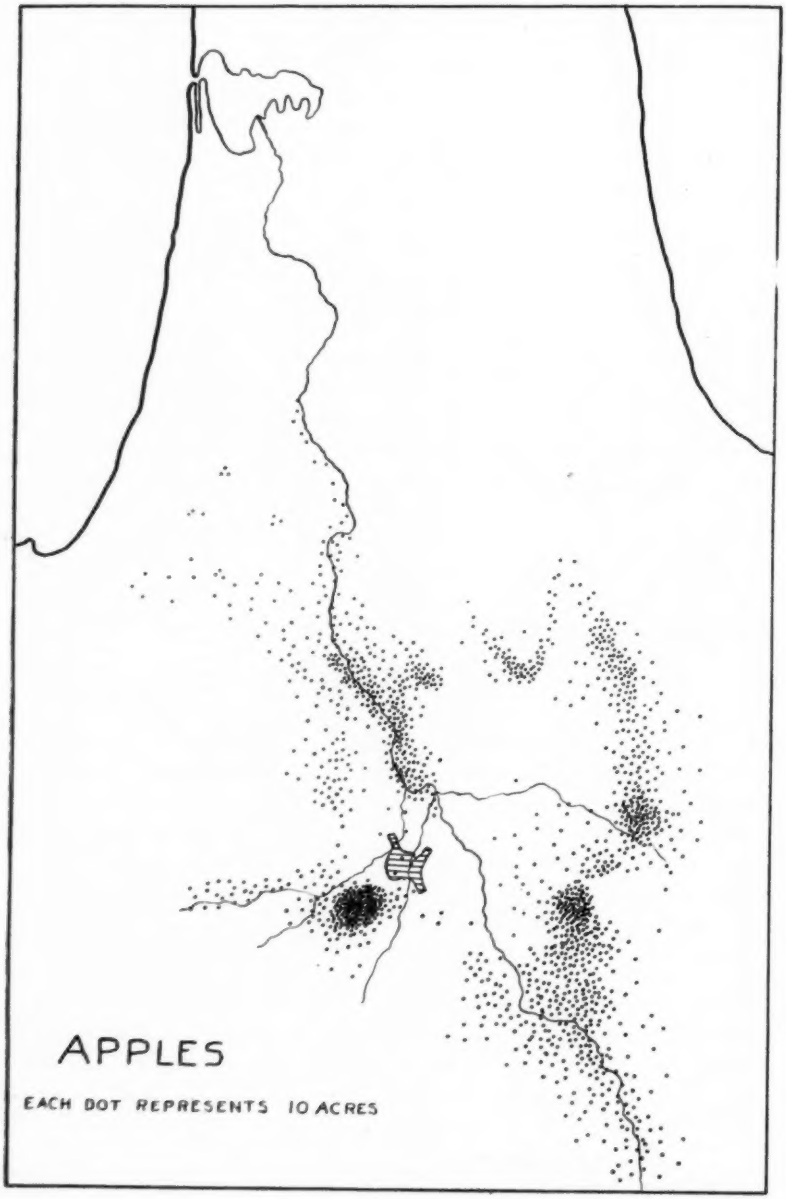
APPLES
EACH DOT REPRESENTS 10 ACRES

FIG. 12—Distribution of apple orchards in Iwaki Basin. Within this basin is grown more than half the apple crop of Japan. Note the concentration of orchards around the margins of the basin on the terraces and lower foothills, and along the Iwaki river in the upper part of the valley.

half the apple crop of Japan is from the region dealt with in this study.[11]

The concentration of nine-tenths of Japan's apple crop in the northern sections of the country, reflects the inability of that tree to thrive in the humid subtropical climates which prevail in middle and southern Nippon. Warmth and humidity are excellent for the growth of wood and foliage, but the fruit under these conditions is of inferior quality. The apple tree is benefited by the longer dormant period which the higher latitudes can provide. The more severe winters in the north are likewise beneficial in that they retard the development and spread of insect pests and fungus diseases, while the shorter cooler summers have a similar effect.

The Iwaki Basin has the distinction of being the oldest as well as the most important apple growing center in Japan. It is difficult for a foreigner to distinguish fact from fiction in the several not-entirely harmonious stories that are current concerning the beginnings of orchard planting in the Hirosaki district. It appears, however, that an American missionary in 1876 or thereabouts brought from New Castle, Indiana, the first apples (perhaps apple seedlings) seen in Iwaki.[12] These seedlings, or perhaps some grown from the seeds of the imported apples, represent the first plantings in northern Honshiu. Very shortly after 1876 the government began the distribution of apple seedlings to the farmers and by 1890 planting had become rather general with shoots being purchased at the rate of 200,000 to 300,000 a year. It was not until the early years of the present century that a serious setback occurred in the apple industry. At about that time insect and fungus pests became so virulent and widespread that disaster threatened. So serious was the calamity that the farmers became discouraged, the importation of new saplings ceased, many

[11] Aomori Prefecture has 1,628,963 of the total of 2,814,000 apple trees in Japan. For comparison's sake it may be noted that New York State alone has over 9,500,000 trees of bearing age.

[12] Conversations with some of the old residents verified by further information from horticulturists at Kuroishi Experiment Station and from a booklet "The Apple in Aomori Ken," published by the prefecture.

orchard men went out of business, apples declined in value because of inferior quality, and numerous orchards were abandoned. These were the "dark ages" in Hirosaki apple culture. After about 1906 a new era seemed to dawn for the fruit growers, since at about that time new methods of combating orchard diseases and pests were discovered or imported and at the same time government aid was enlisted in the struggle to prevent extinction of the apple plantings. A new period of orchard expansion began, not only on the alluvial lands adjacent to the streams where the first plantings had been made, but likewise on the diluvial terraces and mountain foothills which were looked upon as somewhat inferior locations.

The concentration of 50±% of Japan's apple crop in Iwaki no doubt reflects in a measure the inception of the industry in that region. Its persistent growth as an apple center is indicative of attractive natural conditions. Considerable areas of low terrace or irregular alluvial lands difficult to irrigate, in a region of moderate humid-continental climate, constitute the critical combination of factors. In Hokkaido there are large areas of available land, but that island has a relatively meager population, is semi-frontier in its characteristics and unpopular as a place of residence with the Japanese. Its separation from the mainland of Japan has given it additional marketing handicaps. The climate of Hokkaido is less satisfactory for apple culture, the earlier falls and cooler springs making the growing season one and a half months shorter than in northern Honshiu.

Iwaki, which has an average temperature of 64.4° for the seven months period, April to October, inclusive, is pronounced nearly ideal for apple culture by the Japanese horticulturists. This is not unlike temperature conditions at Albany, New York, or Bucharest, Roumania. About the same amount of precipitation (24 inches) falls at Kuroishi from April to October inclusive as in Michigan. Relatively large fluctuations in the quantity of the apple crop from year to year is characteristic of Iwaki, this being partly attributable at least to variable weather conditions which are synchronized with changes in the abundance and virulence of tree and fruit diseases. The heavy snows are something of a handicap, occasionally weighing down and breaking the trees. Covering the land deep with snow induces still another danger, for under those conditions the small herbivorous animals ravenously attack the young trees, doing serious injury to their bark.

Two varieties of apple tree, Ralls Genet (45%) and Jonathan (30%) together occupy three-quarters of the orchard area in Iwaki Basin. The Ralls Genet, while somewhat inferior to Jonathan in flavor, excels it in keeping qualities, which attribute makes it more popular. The remaining 25% of the orchard acreage is largely planted to such varieties as McIntosh Red, Ben Davis, and American Summer Pearmain.

Fruit farming in Iwaki, like tea and mulberry culture in central and southern Japan, is usually an adjunct to general farming. Shima[13] estimates that not more than 10 to 20% of the farmers in the valley are engaged exclusively in the orchard business. Perhaps 35% of the apple crop is produced by these exclusive horticulturists. Because the raising of fruit is chiefly an auxiliary industry among the general farming population, the

FIG. 13—Encasing the young apples in paper sacks.

[13]Formerly in charge of the Horticultural Experiment Station at Kuroishi.

orchards are usually small so that they can be cared for by the farm family.

Characteristically the trees are small and low with oblate crowns, the limbs breaking away from the trunk at right angles, beginning 4-5 feet above the ground. Such size and shape facilitates pruning, spraying, sacking, and picking operations. To combat insect and fungus pests Japanese farmers employ the usual methods of spraying and of jarring the worms from the limbs, but the almost universal practice of encasing each young apple in a paper bag is a protective method not common in America because of prohibitive labor costs (Fig. 13). Paper bags for apple protection are manufactured in the farm homes and by the village folk from old newspapers, the sale price being about 15 sen[14] per 1,000 bags. When in the field in late May and early June it was a common sight on the highways to see farmers returning from Hirosaki with bales of paper bags. The sacks are tied on over the young apple just after the blossom falls, and the fruit makes its full growth inside of this protection, the covers being removed only at maturity when color is desired. The bags serve a twofold purpose: (1) preventing infection of the fruit by insects, and (2) at the same time assuring a thinner and finer-textured skin free from weather blemishes.

Harvesting of apples begins in September and continues until early November. Much of the fruit is placed on the market immediately but varying percentages of the crop are stored in thick-walled "kuras" or godowns where the apples may be kept as late as May. For shipment, the apples are packed in boxes, rice hulls being poured around the fruit to protect it from injury. Probably 90% of the crop is marketed outside of the valley, only an insignificant percentage, however, leaving Japan.

Distribution of Orchards.—There is a marked concentration of orchards in the southern end of the valley where, under the protection of Mt. Iwaki, living conditions are easier and human life as a result is more abundant. The lower valley is more exposed and open to the vigorous northwest winds of winter from off the Sea of Japan, and is more stormy and snowy. The larger areas of diluvial terrace (a common site for orchards) in the upper valley is a further reason for its specialization in fruit. In addition, the proximity to Hirosaki where the marketing organizations are located and where transportation must be sought, is no small

[14] One sen=½ cent United States money.

factor attracting the apple industry to the vicinity of the metropolis (Fig. 12).

Three general types of contrasting sites for apple orchards may be distinguished:

(1) The Irregular Alluvial Lands Along the Rivers.—These are the superior orchard locations. Not only are the soils of higher quality, being deep, friable, and unleached, but proximity to villages makes the work of fertilizing, cultivation, spraying, etc., much easier. More care and attention is therefore lavished upon these orchards with consequent larger yields, 80-100 boxes per tan[15] in lean and productive years respectively.[16] Orchard lands on the alluvium are commonly valued at 450 yen per tan or $900 per acre.

(2) The Diluvial Uplands.—These sites are somewhat less desirable than those on the newer sediments. Where there are large expanses of terrace, as in the upper valley, the orchards may be relatively remote from the villages, since settlements tend to stay close to the paddy areas. The soils of the uplands are relatively infertile, the volcanic ash which mantles the terraces, even in its virgin state, being low in critical minerals, while subsequent leaching has further reduced its productivity. However, the diluvial soils are so variable from place to place that generalizations are difficult. On the broad gently-sloping uplands south and west of Hirosaki where lie the most extensive orchard lands, the soil is a dry, powdery clay-loam with abundant humus, underlain by a heavy subsoil of yellow clay. The powdery upper soil appears almost greasy and it is difficult for rain to penetrate it. Unless frequently moistened the upper soil becomes so arid that the apple trees suffer. The tree roots do not easily penetrate the clay subsoil but tend rather to spread out horizontally in the loose, upper soil. Consequently the trees are less vigorous, which results in their being more quickly injured by drought. This extensive upland south of Hirosaki has a larger area of contiguous orchard than any other section of the valley but its yield of apples per unit area is relatively low. This condition, according to Mr. Shima, can be attributed to the unfavorable soils environment.

In some other parts of the basin the diluvial soils are stony loams with porous sub-soils, which conditions are more nearly ideal for orchards. Because of the variability in upland soils it is im-

[15]One tan=¼ acre.

[16]Information from Mr. Shima, at that time in charge of the Horticultural Experiment Station at Kuroishi.

possible to give figures showing the average yields of orchards on the terraces. In all probability it is intermediate between that of the alluvium and the mountain slopes.

(3) The Mountain Foothills.—The foothills are composed of two principal rock formations from which in turn two contrasting soil types are derived. Where recent volcanic detritus prevails the soils are deep but granular and porous. Soils overlying the sandy shales (probably Tertiary tuff) are infertile, stony, and perilously droughty. The latter type seemed to the writer to predominate. Such soils require frequent and abundant manuring. South, south-east, and south-west exposures are preferred since they receive the maximum insolation and the most complete protection from destructive winds. Crude terracing may be resorted to on very steep slopes although it is not the common practice. Where the angle of slope is great, cover crops are often planted between the trees to protect against slopewash and rapid evaporation. Where clean cultivation is practiced, straw litter or even mats may cover the ground around each tree, thereby conserving the meager soil moisture. Not only is the soil inferior, but the

FIG. 14—Piles of logs along a river at the point where it debouches from the mountains on to the plain. The forest industries are relatively important in the hill country.

steep slopes make for difficulties in cultivation, spraying, picking, and transporting the crop. Animal labor and the use of machinery is almost out of the question. Being farther distant from villages the foothill orchards receive less care and attention.

For all of these reasons the slope orchards are less productive. Fewer trees occupy a unit area and they are commonly smaller and less vigorous. Shima estimates their yield to be 40-50 boxes per tan in lean years and 60-70 per tan in favorable ones, which is only one-half to three-fifths as great as from the orchards on the new alluvium. In addition, the less vigorous trees on the slopes, lacking somewhat in care and attention, are more subject to disease than those of the lowland orchards. The quality of the fruit from the mountain orchards is as fine as, if not actually finer than that produced at lower elevations although the decreased yield much more than offsets this advantage. Consequently the value of the slope orchards, 150-200 yen per tan, is considerably lower than those of riverain locations.

THE HIGHER HILL LANDS AND LOW MOUNTAINS

Close observation of the hill lands was not possible for want of time. Seen from the plain their forms appear rounded rather than sharp although the slopes are frequently steep. From much of the hill land adjacent to the plain the original tree cover has been removed and these slopes are mantled in coarse wild grasses, practically unused. Farther distant from the basin in the more inaccessible hill country, lumbering is still of consequence. To this the piles of logs at the lower ends of the valleys bear witness (Fig. 14).

AN AMENDMENT

The Editor
Annals of the Association of American Geographers

Dear Sir:

In the Brigham memorial number of the ANNALS (June, 1930) a regrettable misstatement is made on page 89 the incorrectness of which is patent to all who are familiar with the origin of the Transcontinental Excursion of 1912 across the United States under the leadership of Professor W. M. Davis. The misstatement reads: " The perfectly conceived itinerary as developed by Professor Davis and Mr. Joerg . . ." The itinerary as well as the whole plan of the excursion were of course conceived solely by Professor Davis. The undersigned, who the year before had joined the staff of the American Geographical Society, the institution under whose auspices the trip was undertaken, was at the invitation of Professor Davis privileged to take part in the excursion as his assistant and in that capacity helped beforehand in the preparation relating to the European geographers invited to participate and, during the excursion, jointly with Professor Frank E. Williams, aided in ministering to their professional needs.

Very truly yours,

W. L. G. JOERG

Nov. 25, 1930.

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